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(54) **PLANAR LIGHT SOURCE DEVICE AND LIQUID CRYSTAL DISPLAY DEVICE**

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(51) **Int. Cl.**
F21V 7/04 (2006.01)

(52) **U.S. Cl.** **362/624**; 362/614; 362/633

(58) **Field of Classification Search** 362/624, 362/632, 633, 626, 627, 628, 614, 97, 29, 362/30

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,490,015 B1 * 12/2002 Kim 349/58
6,552,761 B1 * 4/2003 Seo et al. 349/58
6,979,102 B2 * 12/2005 You 362/218
7,101,055 B2 * 9/2006 Hsieh et al. 362/29
2002/0027774 A1 * 3/2002 Nishiyama et al. 362/29
2006/0209526 A1 * 9/2006 Miyauchi 362/29
2006/0215386 A1 * 9/2006 Hatanaka et al. 362/29

FOREIGN PATENT DOCUMENTS

JP 2001-4983 1/2001

* cited by examiner

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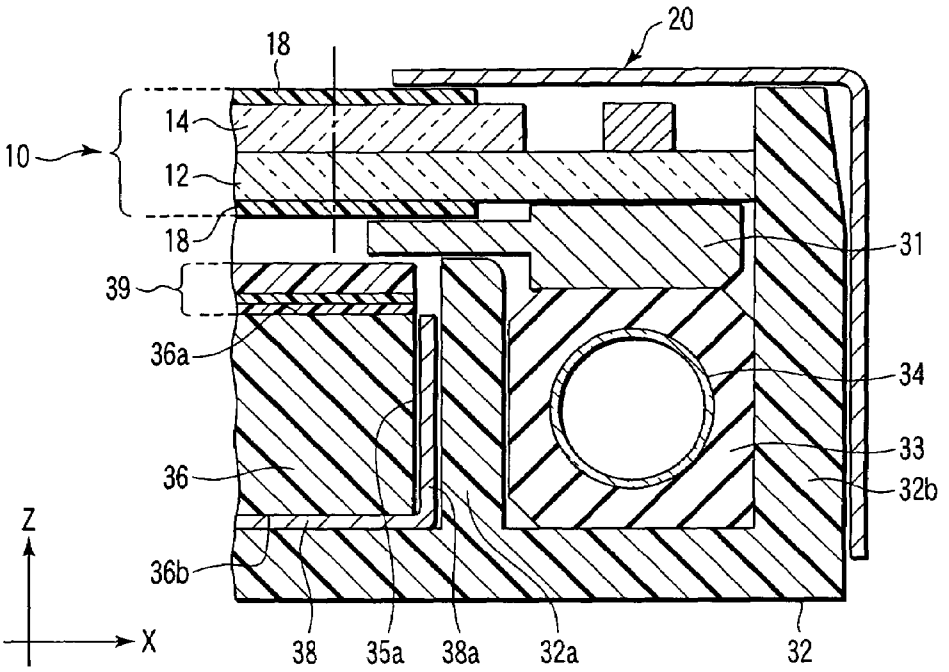
(57) **ABSTRACT**

A planar light source device includes a cold cathode fluorescent tube, a light guide opposed to the light source to emit light which is received from the light source, a frame which supports the light source and the light guide and has a projection which positions the light source and the light guide, and an optical sheet which provides an optical property for light radiated from the light source and has a regulation section that regulates contact between the light guide and the projection of the frame, the regulation section being located between the light guide and the projection.

8 Claims, 3 Drawing Sheets



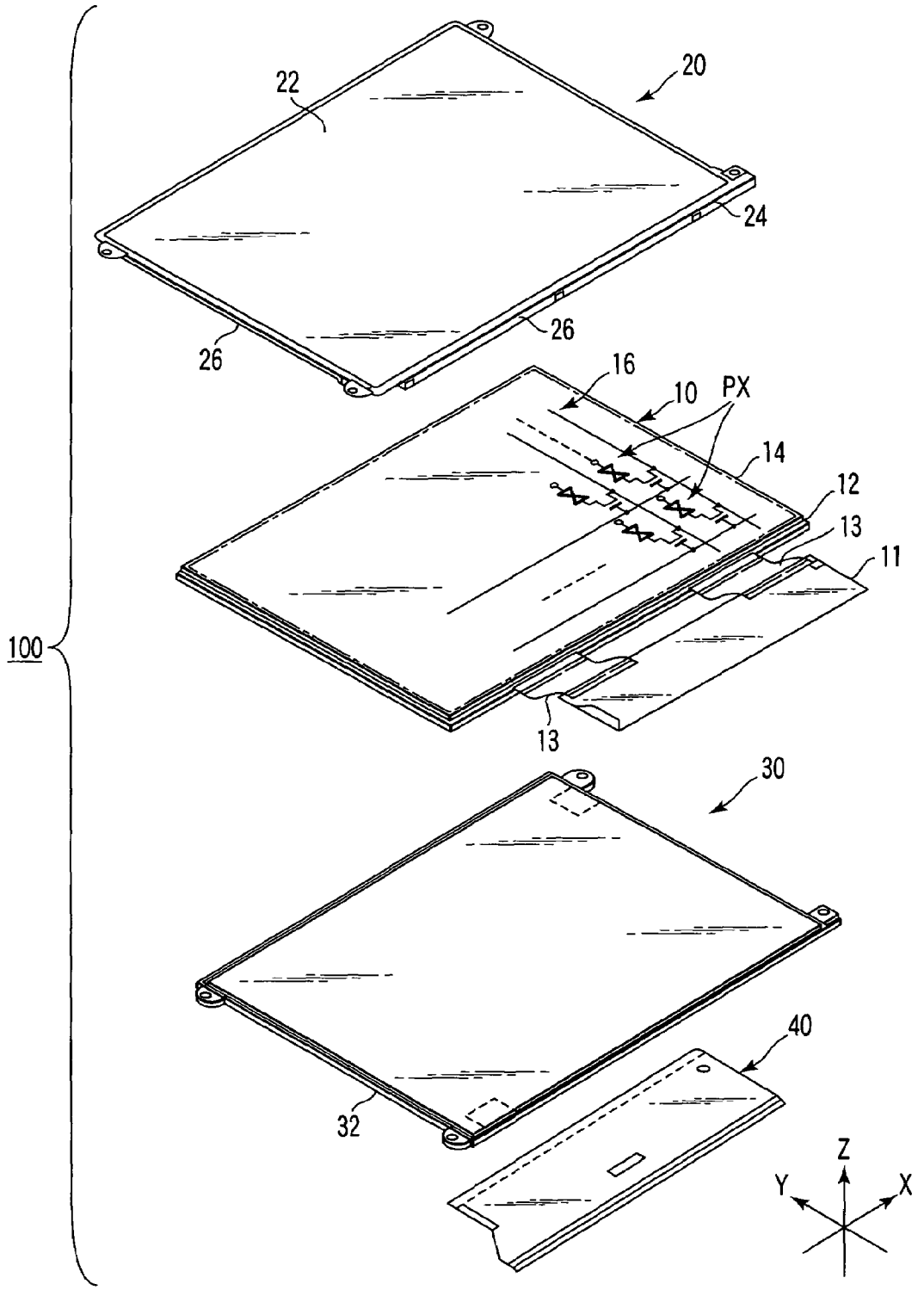


FIG. 1

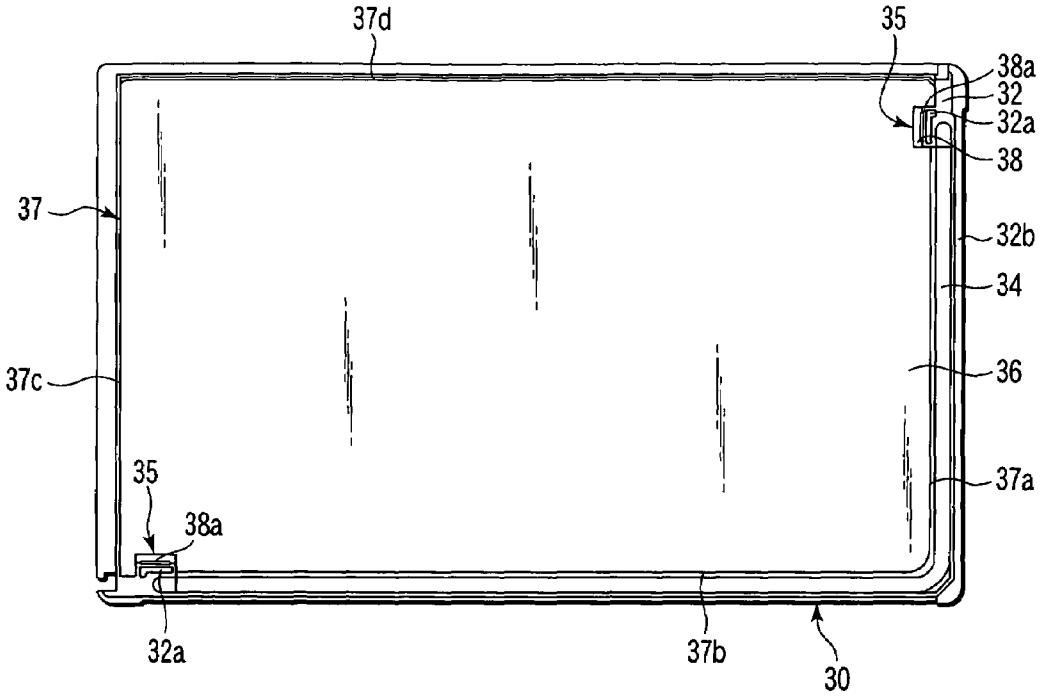

37d
35
38a
32
32a
38
37
32b
34
37c
36
35
37a
38a
32a
37b
30

FIG. 2A

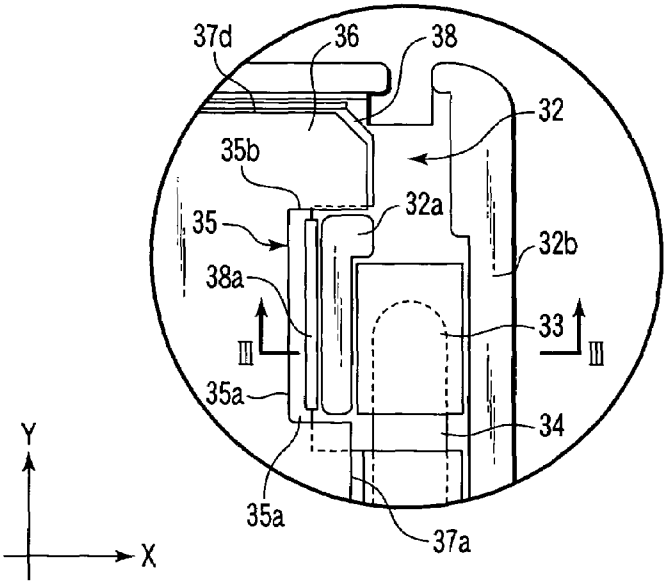

37d
36
38
32
35b
32a
35
32b
38a
33
III
III
35a
34
35a
37a
Y
X

FIG. 2B

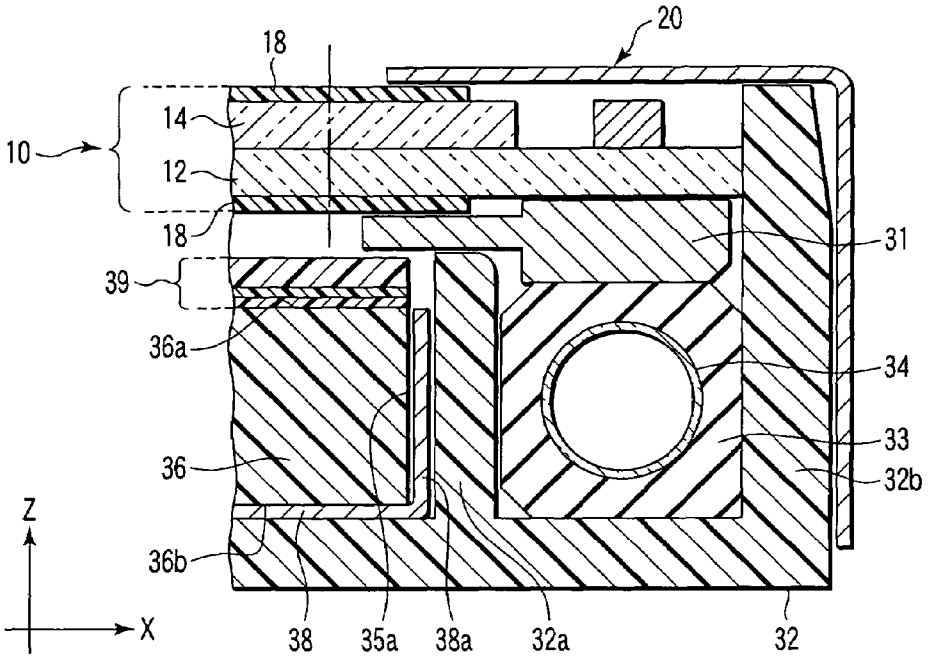

20
18
14
10
12
18
31
39
36a
34
33
36
32b
Z
36b
X
38
35a
38a
32a
32

FIG. 3

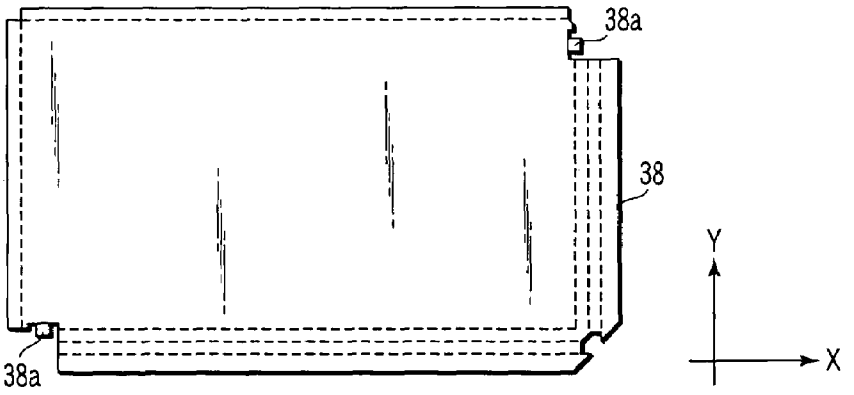

38a
38
Y
38a
X

FIG. 4

PLANAR LIGHT SOURCE DEVICE AND LIQUID CRYSTAL DISPLAY DEVICE

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is based upon and claims the benefit of priority from prior Japanese Patent Application No. 2004-245212, filed Aug. 25, 2004, the entire contents of which are incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a planar light source device that illuminates a liquid crystal display panel, and a liquid crystal display device having the planar light source device.

2. Description of the Related Art

A liquid crystal display device generally includes a liquid crystal display panel that displays an input image and a planar light source device that illuminates the liquid crystal display panel from behind. The liquid crystal display panel is supported by a back frame of the planar light source device and its outer edge is held by a bezel cover with a window section to which an effective display section is exposed.

The planar light source device includes a light source that radiates light and a light guide that receives the light from the light source and emits it toward the liquid crystal display panel. The light guide and the light source are supported by the back frame, and the light source is provided around the light guide. The back frame has a projection that projects between the light source and the light guide. The light source and the light guide are positioned by the projection.

The back frame is formed of, e.g., polycarbonate resin, while the light guide is formed of acrylic resin. Since the back frame and the light guide are formed of such firm materials, the light guide comes into contact with the projection to cause noise when external forces are exerted on the liquid crystal display device to distort the planar light source device.

BRIEF SUMMARY OF THE INVENTION

The present invention has been developed in consideration of the above situation and its object is to provide a planar light source device that suppresses noise caused by contact between a light guide and a projection of a back frame, and a liquid crystal display device having the planar light source device.

According to a first aspect of the present invention, there is provided a planar light source device comprising a light source, a light guide opposed to the light source to emit light which is received from the light source, a frame which supports the light source and the light guide and has a projection which positions the light source and the light guide, and an optical sheet which provides an optical property for light radiated from the light source and has a regulation section that regulates contact between the light guide and the projection of the frame, the regulation section being located between the light guide and the projection.

According to a second aspect of the present invention, there is provided a liquid crystal display device including a liquid crystal display panel having an effective display section in which a plurality of display pixels are arranged and a planar light source device which illuminates the liquid crystal display panel, the planar light source device comprising a light source, a light guide opposed to the light source to emit light which is received from the light source, a frame which supports the light source and the light guide and has a projection which positions the light source and the light guide, and an optical sheet which provides an optical property for light radiated from the light source and has a regulation section that regulates contact between the light guide and the projection of the frame, the regulation section being located between the light guide and the projection.

According to the present invention, a planar light source device that suppresses noise caused by contact between a light guide and a projection of a back frame can be provided, as can be a liquid crystal display device having the planar light source device.

Additional objects and advantages of the invention will be set forth in the description which follows, and in part will be obvious from the description, or may be learned by practice of the invention. The Objects and advantages of the invention may be realized and obtained by means of the instrumentalities and combinations particularly pointed out hereinafter.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING

The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate embodiments of the invention, and together with the general description given above and the detailed description of the embodiments given below, serve to explain the principles of the invention.

FIG. **1** is an exploded, perspective view schematically showing a configuration of a liquid crystal display device having a planar light source device according to an embodiment of the present invention;

FIG. **2**A is a front view of the planar light source device of the liquid crystal display device shown in FIG. **1**;

FIG. **2**B is an enlarged view of a projection of the planar light source shown in FIG. **2**A;

FIG. **3** is a cross-sectional view of the liquid crystal display device shown in FIG. **1**, which is taken along line III-III of FIG. **2**B; and

FIG. **4** is an illustration of an optical sheet of the liquid crystal display device shown in FIG. **1**.

DETAILED DESCRIPTION OF THE INVENTION

A planar light source device according to an embodiment of the present invention, and a liquid crystal display device having the planar light source device will be described with reference to the accompanying drawings.

Referring to FIG. **1**, a liquid crystal display device **100** includes a rectangular liquid crystal display panel **10**, a backlight **30** serving as a planar light source device that illuminates the liquid crystal display panel **10** from behind, and a bezel cover **20** that is attached to a back frame **32** of the backlight **30** to hold the outer edge of the device **100**. The backlight **30** is provided on the back side of the liquid crystal display panel **10** such that they are opposed to each other. The bezel cover **20** is a rectangular frame and attached to the front side of the panel **10**.

Referring to FIGS. **1** and **3**, the liquid crystal display panel **10** includes an array substrate **12** and a counter substrate **14**, which are opposed to each other. A liquid crystal layer is formed between the array substrate **12** and the counter

substrate **14**, and a polarization plate **18** is fixed on the outer surface of each of the array substrate **12** and the counter substrate **14**. The liquid crystal display panel **10** has a substantially rectangular effective display section **16** corresponding to a display area on which an image is displayed. The effective display section **16** is made up of a plurality of display pixels PX arranged in matrix.

A long, narrow, rectangular, plate-like driver circuit **11** is electrically connected to one end of the liquid crystal display panel **10** through a pair of printed wiring boards **13** to supply a drive signal to the panel **10**. The printed wiring boards **13** are each shaped like a flexible, long, narrow, rectangular plate. The driver circuit **11** is provided on the back side of the backlight **30** by bending the boards **13** toward the back side of the backlight **30**. A long, narrow, rectangular insulating sheet **40** is formed between the driver circuit **11** and the backlight **30** to secure insulating properties therebetween.

The bezel cover **20** includes a substantially rectangular window section **22** to which the effective display section **16** of the liquid crystal display panel **10** is exposed, and a rectangular, frame-shaped main body **24** that defines the window section **22**. The main body **24** has an outer edge section **26** that covers the outer edge of the liquid crystal display panel **10** when the panel **10** is held in the main body **24**.

The backlight **30** is substantially rectangular, and its front side is opposed to the back side of the liquid crystal display panel **10** to illuminate the panel **10** from behind. The backlight **30** includes, for example, a substantially L-shaped cold cathode fluorescent tube **34** serving as a light source, a light guide **36** that emits light, which is received from the cold cathode fluorescent tube **34**, toward the liquid crystal display panel **10**, a back frame **32** that supports the cold cathode fluorescent tube **34** and the light guide **36**, and optical sheets **38** and **39** arranged on their respective back and front sides of the light guide **36**.

The back frame **32** is also substantially rectangular and has a face that supports the cold cathode fluorescent tube **34** and the light guide **36** and a frame section **32***b* that faces the sides of the liquid crystal display panel **10** and the cold cathode fluorescent tube **34**.

FIG. **2**(*a*) is a front view of the backlight **30**, and FIG. **2**(*b*) is an enlarged view of the projection **32** provided at a right upper portion of the backlight **30** and the vicinity of the projection **32**. It should be noted that these figures show the backlight **30**, with the optical sheet **39** and front frame **31** removed therefrom, which are shown in FIG. **3**, in order for the backlight **30** to be more easily understood.

Referring to FIGS. **2**A and **2**B, for example, the cold cathode fluorescent tube **34** is provided along the frame section **32***b* on the right and bottom of the back frame **32**. The cold cathode fluorescent tube **34** is a long, narrow, cylindrical light source. A lamp holder **33**, which is formed of, e.g., rubber having elasticity, is attached to either end of the cold cathode fluorescent tube **34**.

The light guide **36** has a first main surface (front side) **36***a* and a second main surface (back side) **36***b*, which are opposed to each other, and four side surfaces **37** (**37***a* to **37***d*) extending between the first and second main surfaces **36***a* and **36***b*. The side surfaces **37***a* and **37***b* are opposed to the cold cathode fluorescent tube **34**, and the first main surface **36***a* is opposed to the back of the liquid crystal display panel **10**. In other words, the side surfaces **37***a* and **37***b* correspond to a light incidence surface that receives light from the cold cathode fluorescent tube **34**, while the first main surface **36***a* corresponds to a light emitting surface that emits light to the liquid crystal display panel **10**.

A projection **32***a* is formed at the back frame **32** and between one end of the cold cathode fluorescent tube **34** and the side surface **37***a* of the light guide section **36**. Another projection **32***a* is formed at the back frame **32** and between the other end thereof and the side surface **37***b* thereof. These projections **32***a* are used to position the cold cathode fluorescent tube **34** and the light guide **36**. Notches **35** are formed in their respective side surfaces **37***a* and **37***b*, and the projections **32***a* are fitted into their respective notches **35**. Each of the notches **35** has a first side surface **35***a* extending substantially parallel to its corresponding one of the side surfaces **37***a* and **37***b* and two second side surfaces **35***b* extending substantially perpendicularly to the first side surface **35***a*.

The optical sheet **38** arranged on the back side **36***b* of the light guide **36** provides a given optical property for light leaking from the back side **36***b*. In other words, the optical sheet **38** is a reflecting sheet that reflects light leaking from the back side **36***b* and the side surfaces **37** toward the light guide **36**. On the other hand, the optical sheet **39** arranged on the front side **36***a* of the light guide **36** provides a given optical property for light radiated from the front side **36***a*. The optical sheet **39** is a light-collecting sheet, a light-diffusing sheet or the like.

The optical sheet **38** has tongues **38***a* as regulation sections. Each of the tongues **38***a* extends from the optical sheet **38** and is folded along the first side surface **35***a* of the notch **35**. It is thus arranged between the notch **35** and the projection **32***a*.

As illustrated in FIG. **4**, the optical sheet **38** is substantially rectangular and its upper right-hand and lower left-hand corners are cut substantially rectangularly. The tongue **38***a* is also substantially rectangular and positioned in agreement with each of the projections **32***a* in the upper right-hand and lower left-hand corners of the optical sheet **38**.

The light guide **36** is located within a range that is defined by the dotted lines along the upper and left sides of the optical sheet **38** and the innermost ones of the dotted lines along the lower and right sides thereof. The cold cathode fluorescent tube **34** is located between the light guide **36** and the middle ones of the dotted lines along the lower and right sides of the optical sheet **38**.

The tongues **38***a* of the optical sheet **38** are folded along their respective side surfaces **37***c* and **37***d* of the light guide **36** and each located between the light guide **36** and the projection **32***a*. The portions of the optical sheet **38**, which are outside the dotted lines along the upper and left sides, are folded along these dotted lines to cover the side surfaces **37***c* and **37***d* of the light guide **36**, neither of which is opposed to the cold cathode fluorescent tube **34**. The portions of the optical sheet **38**, which are outside the middle ones of the dotted lines along the lower and right sides, are folded twice to cover the side and top surfaces of the cold cathode fluorescent tube **34**, neither of which is opposed to the light guide **36**.

It is desirable that the height of the tongue **38***a*, which is folded along the first side surface **35***a* of the notch **35** of the light guide **36**, be at least not less than half the height of the light guide **36**. It is also desirable that the width of the tongue **38***a* be not less than half the width of the projection.

The widths of the tongue **38***a*, projection **32***a* and notch **35** correspond to the lengths thereof in the direction (Y direction) that is almost perpendicular to line III-III of FIG. **2**B.

The heights of the folded tongue **38***a* and the light guide **36** correspond to the lengths thereof in the Z direction shown in FIG. **3**.

If, as described above, the tongue **38***a* is formed at the optical sheet **38** as a regulation section and arranged between the light guide **36** and the projection **32***a* of the back frame **32**, the light guide **36** and the projection **32***a* do not come into direct contact with each other. Even though both the projection **32***a* and the light guide **36** are made of firm materials, noise due to contact between the light guide **36** and the projection **32***a* can be suppressed without adding any new components.

Even though light that radiates from the cold cathode fluorescent tube **34** leaks from the second main surface **36***b* of the light guide **36** and the side surface thereof which does not face the cold cathode fluorescent tube **34**, the optical sheet **38** can reflect the leakage light in the direction of the light guide **36**.

In the above embodiment, the tongue **38***a* of the optical sheet **38** formed on the second main surface **36***b* of the light guide **36** is folded from below the light guide **36** and positioned between the light guide **36** and the projection **32***a*. However, the tongue can be formed on the optical sheet **39** formed on the first main surface **36***a* of the light guide **36**, folded along the side surface **37** from the first main surface **36***a*, and positioned between the light guide **36** and the projection **32***a*.

In the above embodiment, the substantially L-shaped cold cathode fluorescent tube **34** is used as a light source. However, a substantially linear cold cathode fluorescent tube can be used. In this case, it is desirable to form the light guide **36** as not a substantially rectangular plate but a wedge that gradually decreases in thickness from one side that receives light from the cold cathode fluorescent tube to the other side. Such a configuration can produce the same advantages as those of the above embodiment.

Additional advantages and modifications will readily occur to those skilled in the art. Therefore, the invention in its broader aspects is not limited to the specific details and representative embodiments shown and described herein. Accordingly, various modifications may be made without departing from the spirit or scope of the general inventive concept as defined by the appended claims and their equivalents.

What is claimed is:

1. A planar light source device comprising:

a light source;

a light guide opposed to the light source to guide light which is received from the light source;

a frame which supports the light source and the light guide, and has a projection which positions the light source and the light guide; and

an optical sheet which provides an optical property for light radiated from the light source, and has a regulation section that regulates contact between the light guide and the projection of the frame, the regulation section being located between the light guide and the projection.

wherein the light guide has a first main surface from which light is to be emitted, a second main surface that is a back side of the first main surface and is opposed to the frame, and a side surface that extends between the first main surface and the second main surface and is opposed to the projection, and

the optical sheet is opposed to one of the first main surface and the second main surface, and the regulation section has a tongue that extends from the optical sheet and is folded along the side surface of the light guide.

2. The planar light source device according to claim **1**, wherein the light guide has a light incidence surface that receives light from the light source, and the first main surface from which light received from the light incidence surface is to be emitted, and

the optical sheet is arranged on the first main surface of the light guide, and the tongue is provided at the optical sheet.

3. The planar light source device according to claim **1**, wherein the light guide has a light incidence surface that receives light from the light source, and the first main surface from which light received from the light incidence surface is to be emitted, and

the optical sheet is arranged between the frame and the second main surface of the light guide, and the tongue is provided at the optical sheet.

4. A planar light source device comprising:

a light source;

a light guide opposed to the light source to guide light which is received from the light source;

a frame which supports the light source and the light guide, and has a projection which positions the light source and the light guide; and

an optical sheet which provides an optical property for light radiated from the light source, and has a regulation section that regulates contact between the light guide and the projection of the frame, the regulation section being located between the light guide and the projection,

wherein the optical sheet is substantially rectangular and larger than a section in which the light guide and the light source are arranged, and

the optical sheet is arranged to cover a side surface of the light guide which is not opposed to the light source, a side surface or a top surface of the light source which is not opposed to the light guide.

5. A liquid crystal display device including a liquid crystal display panel having an effective display section in which a plurality of display pixels are arranged and a planar light source device which illuminates the liquid crystal display panel,

the planar light source device comprising:

a light source;

a light guide opposed to the light source to guide light which is received from the light source;

a frame which supports the light source and the light guide and has a projection which positions the light source and the light guide; and

an optical sheet which provides an optical property for light radiated from the light source and has a regulation section that regulates contact between the light guide and the projection of the frame, the regulation section being located between the light guide and the projection,

wherein the light guide has a first main surface that is opposed to the liquid crystal display panel, a second main surface that is opposed to the frame, and a side surface that extends between the first main surface and the second main surface and is opposed to the projection, and

the optical sheet is opposed to one of the first main surface and the second main surface, and the regulation section has a tongue that extends from the optical sheet and is folded along the side surface of the light guide.

6. The liquid crystal display device according to claim 5, wherein the light guide has a light incidence surface that receives light from the light source, and the first and second main surfaces of the light guide are opposed to each other from which light received from the light incidence surface is to be emitted, and

the optical sheet is arranged on the first main surface of the light guide, and the tongue is provided at the optical sheet.

7. The liquid crystal display device according to claim 5, wherein the light guide has a light incidence surface that receives light from the light source, and the first and second main surfaces of the light guide are opposed to each other from which light received from the light incidence surface is to be emitted, and

the optical sheet is arranged between the frame and the second main surface of the light guide, and the tongue is provided at the optical sheet.

8. The liquid crystal display device according to claim 5, wherein the optical sheet is each substantially rectangular and larger than a section in which the light guide and the light source are arranged, and

the optical sheet is arranged to cover a side surface of the light guide which is not opposed to the light source, and a side surface or a top surface of the light source which is not opposed to the light guide.

* * * * *